WE CLAIM:

1. An adaptive and synergic fill welding apparatus for joining at least a first work piece and a second work piece along a joint having a variable joint profile, comprising:

a means for profiling and tracking the joint;

a means for welding the joint by creating an electrical arc between a tip of a consumable electrode and the first or second work piece thereby melting the electrode and producing a weld bead at a predetermined weld bead size;

a means for feeding the consumable electrode to the welding means at a predetermined wire feed speed;

a means for controlling the power necessary to create the electrical arc;

a means for adjusting the location of the profiling and tracking means and the welding means;

a means for adjusting the rotation of the welding means;

a means for moving the profiling and tracking means, the welding means, the location adjusting means, the rotation adjusting means, and the electrode feed means, along the joint at a predetermined travel speed;

a portable means for user input and display;

a means for controlling the welding means, the location adjusting means, the rotation adjusting means, the electrode feed means, the moving means, and the power controlling means based upon input from the profiling and tracking means and the user input and display means to obtain a predetermined base metal dilution; and

a means for communicating a plurality of input and output commands, and power among the various means of this apparatus.

2. The apparatus of claim 1, wherein the control means includes an adaptive fill mode wherein the predetermined weld bead size is adaptively modified, with no external intervention, relative to changes in a layer width to account for changes in the joint profile.

3. The apparatus of claim 1, wherein the user input and display device includes a manual synergic fill regulation device for the user to externally influence the weld bead size to account for changes in the joint profile.

4. The apparatus of claim 3, wherein the control means includes a synergic fill mode wherein the synergic fill regulation device is adapted to change a synergic fill number, representing a ratio of the predetermined wire feed speed to the predetermined travel speed during welding, thereby changing the predetermined weld bead size.

5. The apparatus of claim 4, wherein the control means references a plurality of electronic arrays, stored in at least one memory device, containing a plurality of optimized welding parameters, selected to obtain the predetermined base metal dilution, for a plurality of welding pass categories and a plurality of synergic fill numbers.

6. The apparatus of claim 5, wherein the predetermined base metal dilution is between approximately 30% and approximately 70%.

7. The apparatus of claim 5, wherein the predetermined base metal dilution is between approximately 40% and approximately 50%.

8. The apparatus of claim 5, wherein the plurality of welding pass categories includes a root pass, a fill pass, and a cap pass.

9. The apparatus of claim 5, wherein the plurality of optimized welding parameters include the predetermined wire feed speed, the predetermined travel speed, a welding voltage, a welding current, an oscillation width of the welding means, at least one dwell time for the welding means, and a plurality of bead size parameters.

10. The apparatus of claim 9, wherein the plurality of bead size parameters includes a bead width, a bead depth, at least one leg length, and at least one leg toe angle.

11. The apparatus of claim 1, wherein the input and display means includes a manual welding voltage regulation device for a user to externally influence a voltage of the electrical arc to account for power transmission losses between the welding means and the power controlling means.

12. The apparatus of claim 1, wherein the input and display means includes a manual axis adjustment device for a user to externally influence the location adjusting means and the rotation adjusting means, thereby adjusting the position of the welding means during welding, including

adjustment of the welding means along a longitudinal axis, a transverse axis, an orthogonal axis, and a torch trajectory plane.

13. The apparatus of claim 1, wherein the profiling means includes a laser sensor system.

14. The apparatus of claim 13, wherein the laser sensor system includes at least one laser and at least one camera.

15. The apparatus of claim 13, wherein the laser sensor system utilizes laser triangulation to obtain a plurality of joint profile data.

16. The apparatus of claim 1, wherein the welding means is selected from the group consisting of a flux-cored arc welding torch, a gas-metal arc welding torch, and a submerged arc welding process.

17. The apparatus of claim 1, wherein the moving means includes at least one carriage and at least one cooperating rail attached to the first or second work piece.

18. An adaptive and synergic fill welding apparatus for joining at least a first work piece and a second work piece along a joint having a variable joint profile, comprising:

a means for profiling and tracking the joint;

a means for welding the joint by creating an electrical arc between a tip of a consumable electrode and the first or second work piece thereby melting the electrode and producing a weld bead at a predetermined weld bead size;

a means for feeding the consumable electrode to the welding means at a predetermined wire feed speed;

a means for controlling the power necessary to create the electrical arc;

a means for adjusting the location of the profiling and tracking means and the welding means;

a means for adjusting the rotation of the welding means;

a means for moving the profiling and tracking means, the welding means, the location adjusting means, the rotation adjusting means, and the electrode feed means, along the joint at a predetermined travel speed;

a portable means for user input and display having a manual synergic fill regulation device for the user to externally influence the weld bead size to account for changes in the joint profile;

a means for controlling the welding means, the location adjusting means, the rotation adjusting means, the electrode feed means, the moving means, and the power controlling means based upon input from the profiling and tracking means and the user input and display means to obtain a predetermined base metal dilution, wherein the control means includes a synergic fill mode wherein the synergic fill regulation device is adapted to change a synergic fill number, representing a ratio of the predetermined wire feed speed to the predetermined travel speed during welding, thereby changing the predetermined weld bead size, and the control means references a plurality of electronic arrays, stored in at least one memory device, containing a

plurality of optimized welding parameters, selected to obtain the predetermined base metal dilution, for a plurality of welding pass categories and a plurality of synergic fill numbers; and

a means for communicating a plurality of input and output commands, and power among the various means of this apparatus.

19. The apparatus of claim 18, wherein the control means includes an adaptive fill mode wherein the predetermined weld bead size is adaptively modified, with no external intervention, relative to changes in a layer width to account for changes in the joint profile.

20. The apparatus of claim 18, wherein the predetermined base metal dilution is between approximately 30% and approximately 70%.

21. The apparatus of claim 18, wherein the predetermined base metal dilution is between approximately 40% and approximately 50%.

22. The apparatus of claim 18, wherein the plurality of welding pass categories includes a root pass, a fill pass, and a cap pass.

23. The apparatus of claim 18, wherein the plurality of optimized welding parameters include the predetermined wire feed speed, the predetermined travel speed, a welding voltage, a welding current, an oscillation width of the welding means, at least one dwell time for the welding means, and a plurality of bead size parameters.

24. The apparatus of claim 23, wherein the plurality of bead size parameters includes a bead width, a bead depth, at least one leg length, and at least one leg toe angle.

25. The apparatus of claim 18, wherein the input and display means includes a manual welding voltage regulation device for a user to externally influence a voltage of the electrical arc to account for power transmission losses between the welding means and the power controlling means.

26. The apparatus of claim 18, wherein the profiling means includes a laser sensor system.

27. The apparatus of claim 26, wherein the laser sensor system includes at least one laser and at least one camera.

28. The apparatus of claim 27, wherein the laser sensor system utilizes laser triangulation to obtain a plurality of joint profile data.

29. An adaptive and synergic fill welding apparatus for joining at least a first work piece and a second work piece along a joint having a variable joint profile, comprising:

a laser based means for profiling and tracking the joint having at least one laser and at least one camera working in conjunction utilizing laser triangulation to obtain a plurality of joint profile data;

a means for welding the joint by creating an electrical arc between a tip of a consumable electrode and the first or second work piece thereby melting the electrode and producing a weld bead at a predetermined weld bead size;

a means for feeding the consumable electrode to the welding means at a predetermined wire feed speed;

a means for controlling the power necessary to create the electrical arc;

a means for adjusting the location of the profiling and tracking means and the welding means;

a means for adjusting the rotation of the welding means;

a means for moving the profiling and tracking means, the welding means, the location adjusting means, the rotation adjusting means, and the electrode feed means, along the joint at a predetermined travel speed;

a portable means for user input and display having a manual synergic fill regulation device for the user to externally influence the weld bead size to account for changes in the joint profile;

a means for controlling the welding means, the location adjusting means, the rotation adjusting means, the electrode feed means, the moving means, and the power controlling means based upon input from the profiling and tracking means and the user input and display means to obtain a predetermined base metal dilution, wherein the control means includes a synergic fill mode wherein the synergic fill regulation device is adapted to change a synergic fill number, representing a ratio of the predetermined wire feed speed to the predetermined travel speed during welding, thereby changing the predetermined weld bead size, and the control means references a plurality of electronic arrays, stored in at least one memory device, containing a

plurality of optimized welding parameters including the predetermined wire feed speed, the predetermined travel speed, a welding voltage, a welding current, an oscillation width of the welding means, at least one dwell time for the welding means, and a plurality of bead size parameters, selected to obtain the predetermined base metal dilution between approximately 30% and 70%, for a plurality of welding pass categories and a plurality of synergic fill numbers; and

a means for communicating a plurality of input and output commands, and power among the various means of this apparatus.

30. The apparatus of claim 29, wherein the predetermined base metal dilution is constant over an entire length of the weld.